

**DEVICES, METHODS AND COMPUTER
PROGRAM PRODUCTS FOR AN IMPROVED
HANDOVER IN INTER-SITE CARRIER
AGGREGATION SCENARIOS**

FIELD OF THE INVENTION

[0001] The present invention relates to devices, methods and computer program products for an improved handover in inter-site carrier aggregation scenarios. In particular, the present invention relates to such devices, methods and computer program products applicable in mobile communication systems operating based on carrier aggregation, in which a primary cell/carrier is relocated during a handover in an inter-site carrier aggregation scenario.

BACKGROUND

[0002] Mobile data transmission and data services are constantly making progress. With the increasing penetration of such services, a terminal apparatus such as a user equipment UE (or mobile station MS, or the like; different names may apply for respective different standards) is capable of communicating using multiple frequencies or frequency bands and accessing various services. Data throughput is becoming more and more important in view of an increasing amount of data to be conveyed or carried for those services. According to one aspect to increase data throughput, a terminal UE is supplied or served from e.g. plural sources (sites) (e.g. base stations BS or NodeB's, NB or evolved NodeBs, eNB) using plural carriers in carrier aggregation (CA). This is also referred to as inter-site carrier aggregation if the carriers are provided via distinct sites (in contrast to intra-site carrier aggregation in which one site, e.g. eNB, aggregates the plural carriers "alone").

[0003] In the following, aspects of the invention will be exemplarily described. In order to enhance legibility and understandability of the invention, for explanatory purposes only, reference is made to the communication system of LTE or LTE-A (Long Term Evolution, LTE-Advanced). However, reference to such specific system and using of specific signaling names or channel names is not intended to limit the present invention to those specific examples. Rather, the principles of the present invention can be transferred to any other communication system adopting different channel/signaling names as LTE/LTE-A.

[0004] Along with the development of LTE system, high-speed data service has been treated as one of the most important requirements. Especially for local area network, higher data rate is expected from user's perspective. How to provide local service with high speed data rate has become a hot topic in 3GPP (3rd Generation Partnership Project).

[0005] LTE-LAN (LTE-Local Area Network) is a research activity to compete with world-wide popular WiFi® or WLAN (Wireless Local Area Network) technique. LTE-LAN is basically assumed to be based on LTE technology, but is more focused on some local area use cases and scenarios. LTE-LAN is expected to provide high performance service for users with low cost, and is expected to become a competitor to WiFi®.

[0006] Applicant is involved in investigating in such area, with a focus on potential LTE local area architectures as one of plural research topics. One of the most promising local area

concepts identified in such preliminary works is the architecture based on the LTE-LAN (which is currently referred to as "LTE Hi-concept").

[0007] Basic assumptions in this concept are:

[0008] Dual band operation in that local area and wide area accesses are using different radio bands,

[0009] Autonomous (local area) operation to mobile core network in that the usage of LTE-LAN network is transparent to a core network for simplicity and for keeping the signaling load low,

[0010] Offloading of LTE wide area network resources (EPS (Evolved Packet System) Bearer Services) to use LTE-LAN network resources in control of the serving eNB of the UE at E-UTRAN level (Evolved Universal Terrestrial Radio Access Network).

[0011] At the moment, in 3GPP Rel-12 and above there is also some interest in studying Inter-Site Carrier Aggregation with LTE, where a Primary Component Carrier (PCC, PCell primary Cell) is transmitted via e.g. a macro eNB and one or more Secondary component carriers (SCCs, SCells or Secondary Cells) is transmitted via e.g. one or more pico eNBs. Note that as used herein below 'PCell/eNB' is designated to denote a primary eNB and 'SCell BS' is designated to denote a secondary base station, and so on, as also the primary node may provide also SCells in Rel-10 fashion alongside those provided from the secondary node(s). Thus, there is only one Pcell for the UE. Apart from that, any base station can transmit several SCells to that UE. "Inter-site" thus means that at least one SCell is not co-sited with the PCell.

[0012] In general, the mentioned "LTE-Hi concept" may support Inter-Site and "multi-radio" CA, where a serving eNB is in a role of a primary cell, PCell, and "LTE-Hi" Access Points (APs) are each in a role of a respective secondary cell, SCell.

[0013] In the LTE-LAN or Inter-Site CA concepts targeted for 3GPP Rel-12, a terminal UE may move within the network coverage, so that there may be situations in which a current SCell (the pico cell or the LTE-LAN AP) has proper signal but the Serving macro eNB or the PCell is not any longer anymore the best cell. This will necessitate in an Inter eNB handover/PCell Relocation procedure to be carried out.

[0014] Though, so far in the context of Inter Site CA studies, there have not been any discussions known by the inventors about such a scenario, because the CA scenario considered in 3GPP so far are assuming PCell and SCell being controlled by the same eNB (Intra-site CA).

[0015] In 3GPP standardization, the Inter Site Carrier Aggregation is not supported before the coming Rel-12 due to an assumption that a backhaul link (the X2 interface) between eNBs has constraints in terms of latency and capacity (3GPP TR 36.814). For such reason, inter-site CA remained unconsidered (omitted) so far.

[0016] A reason for this is that the current Intra Site Carrier Aggregation is supposed to happen at the radio link layer (below RLC in LTE radio stack), so that the fast radio control loop on all the CCs must be terminated at the primary eNB. Thus, it has not been feasible to consider relocation of only a subset of a UE's serving cells so far, but CA mobility is assumed to be handled by removing/adding secondary CC(s) in conjunction with Inter PCell handover procedures, i.e. (at first) terminate CA operation temporarily (terminate any secondary carriers/cells) and then, if possible, restart CA and the secondary carriers/cells after the PCell handover was executed.